Magnetization and Loss Measurements of YBCO CORC and Roebel Cables for Accelerators using ±3 T dipole Susceptometer

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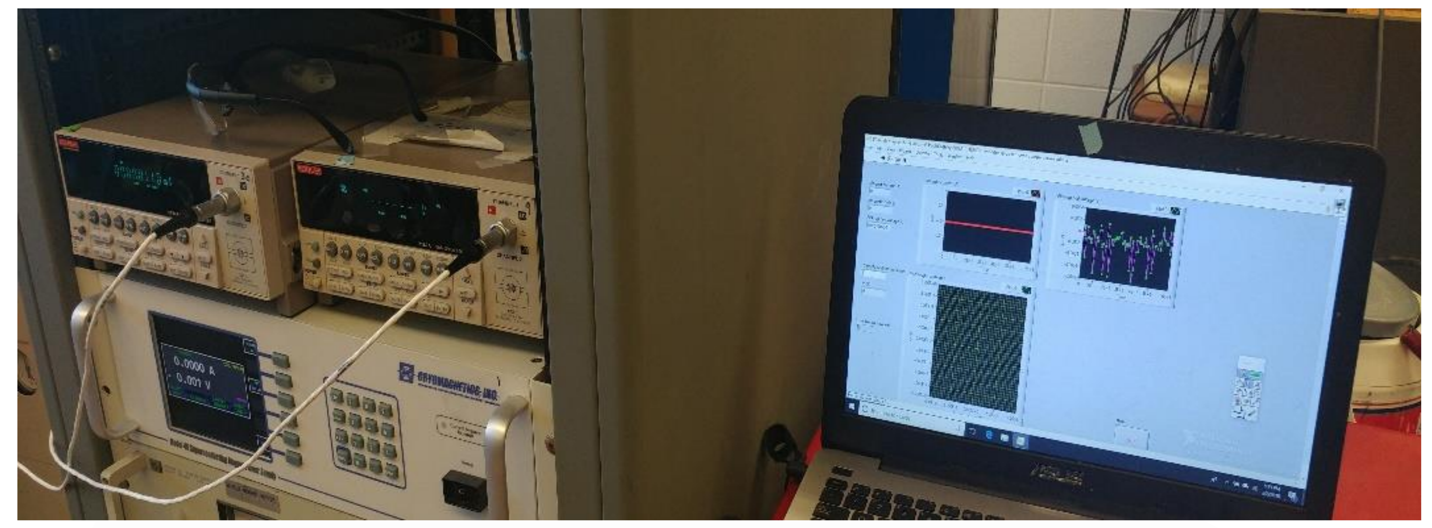
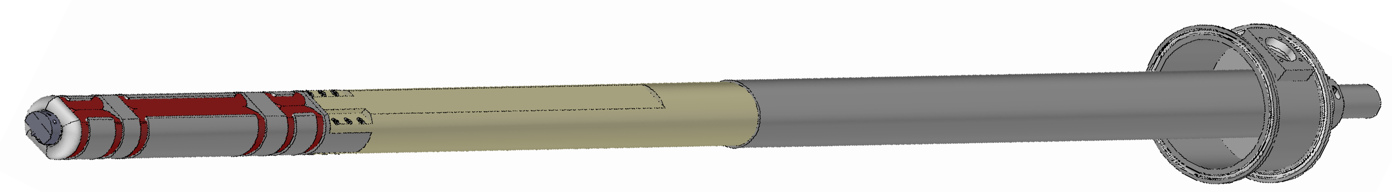
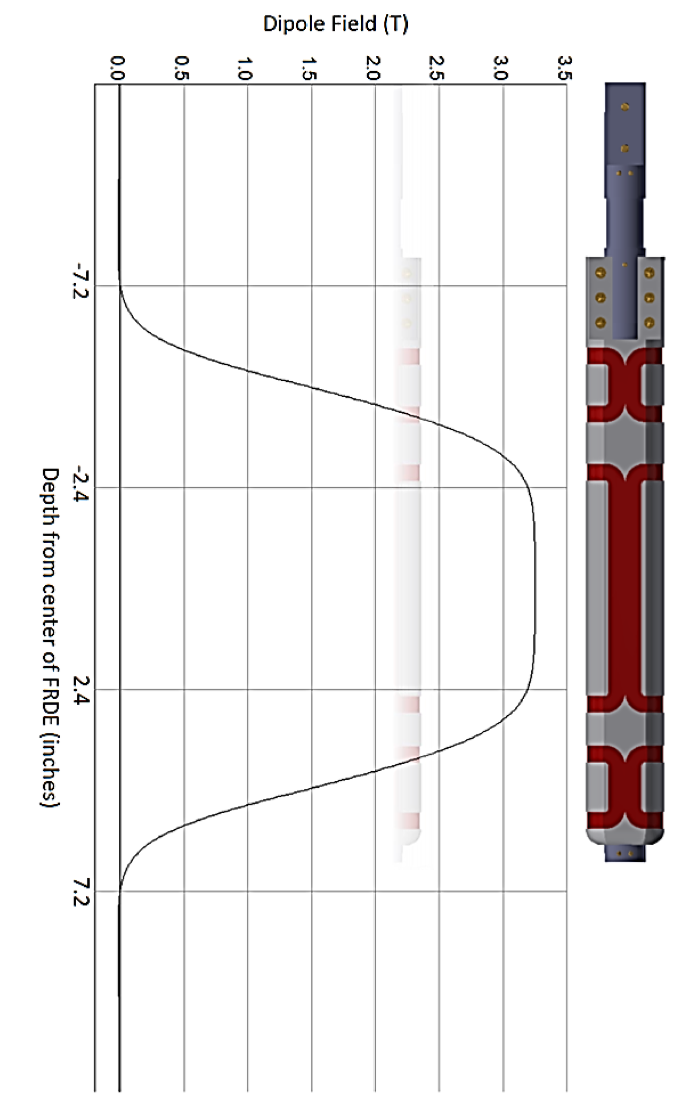
Abstract

- We present measurements on superconducting cables using a new 3 T dipole AC susceptometer. Two sample types were measured, YBCO CORC and Roebel cables.
- The Roebel cable was a 9-5.6 style, and was measured as a single layer in direct helium and no epoxy impregnation. For measurement the samples were inserted in a G-10 holder.
- The CORC sample had 16 tapes, and was 3.21 mm OD, carrying 4 kA at 4 K self field
- Pick-up coils surrounded the sample and a set of compensation coils was used to buck out the base field.
- The signals read using DAQ from nanovoltmeters which monitored the pickup coils, and the data read using a labview software program.
- The background magnet is a bipolar 3 T magnet wound with NbTi
- Roebel and CORC measurements are compared to one another and to the tapes they are made with

Figure 1. Dipole magnet, sample holder, and outer pickup coils







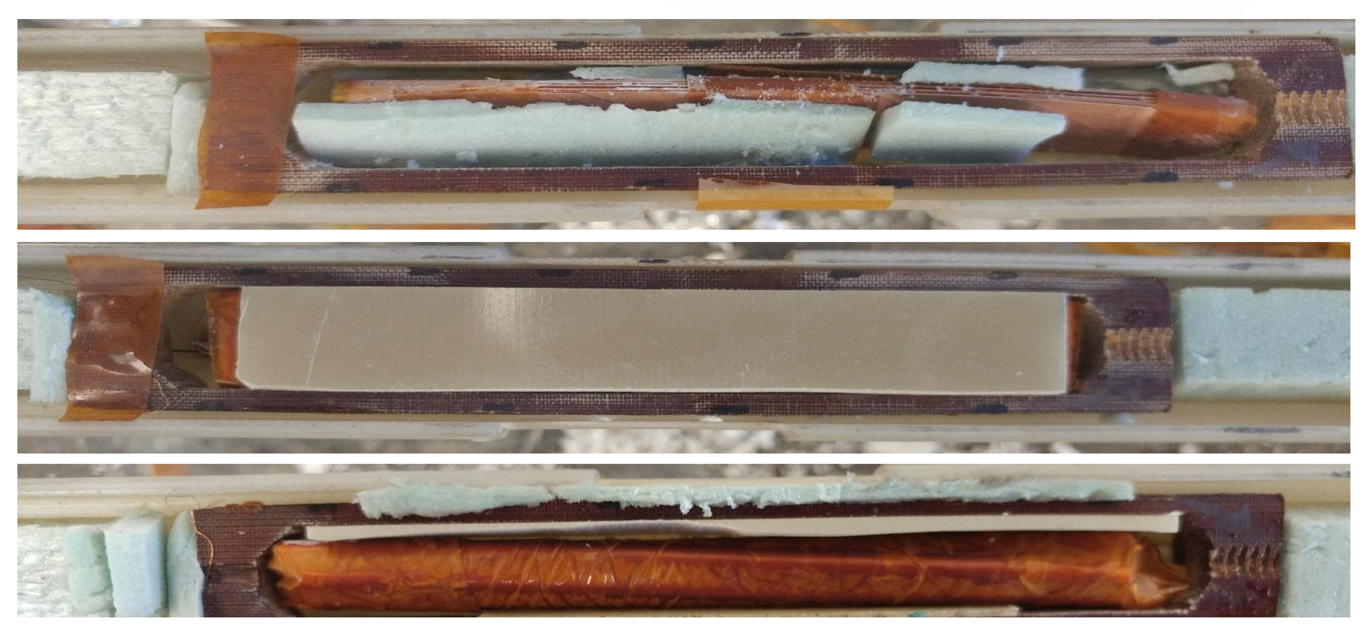


Figure 2. Measurement system, outer assembly diagram and actual, samples in pick-up coils

Cable	*# tapes*	*Cable Dim, mm*	*Cable I_c, A (4 K, SF)*	*Tape I_c, A (4K, SF)*	*Tape w, mm*	*Tape/cable*
CORC	16	3.21 (OD)	4000	250	2	*0.34*
Roebel	9	12 x 0.48	*1068 x 10 est*	1180 est	5.6	*0.84*
Sample	***# Segments***	***Pack dim, mm***	***L, mm***	***V_{cable}, mm^3***	***V_{strand}, mm^3***	***L_p, mm***
CORC	6	10 (OD)	94.2	4571	1591	6
Roebel	4	4.3 x 12	90.7	2089	1755	126

Estimations for LBNL CORC samples

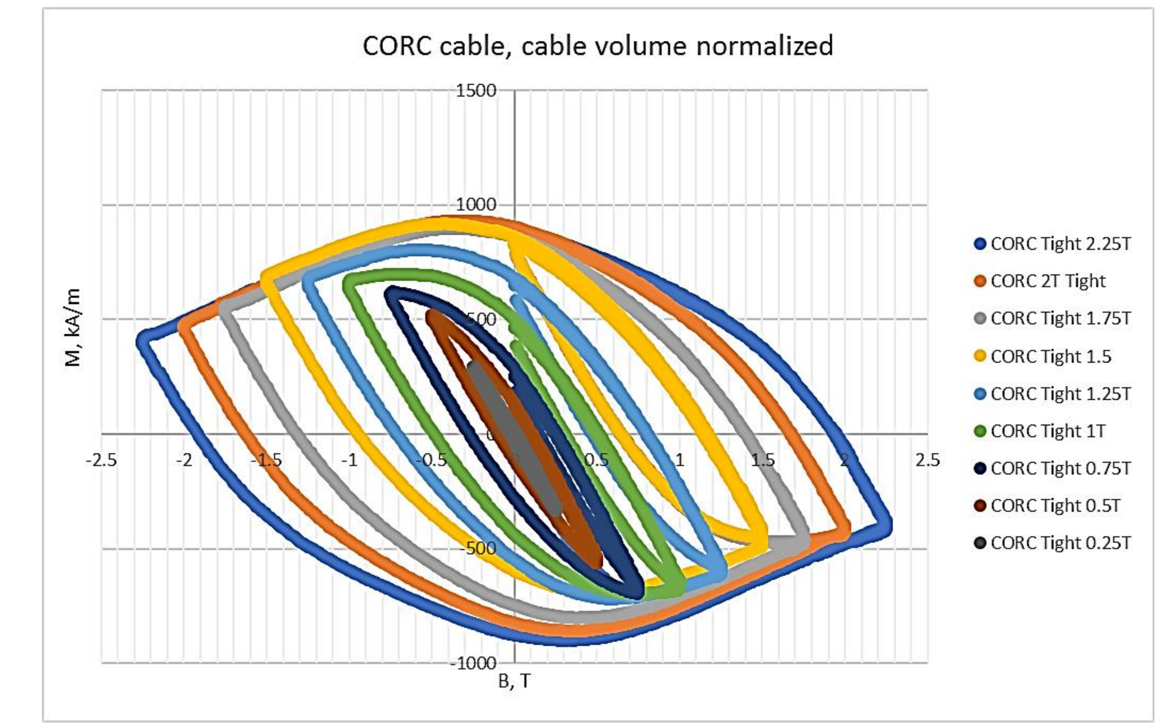
- CORC A: 16-tape wire, wire OD 3.09 mm (including the heat shrink tubing), I_c = 4 kA at 4.2 K, self-field

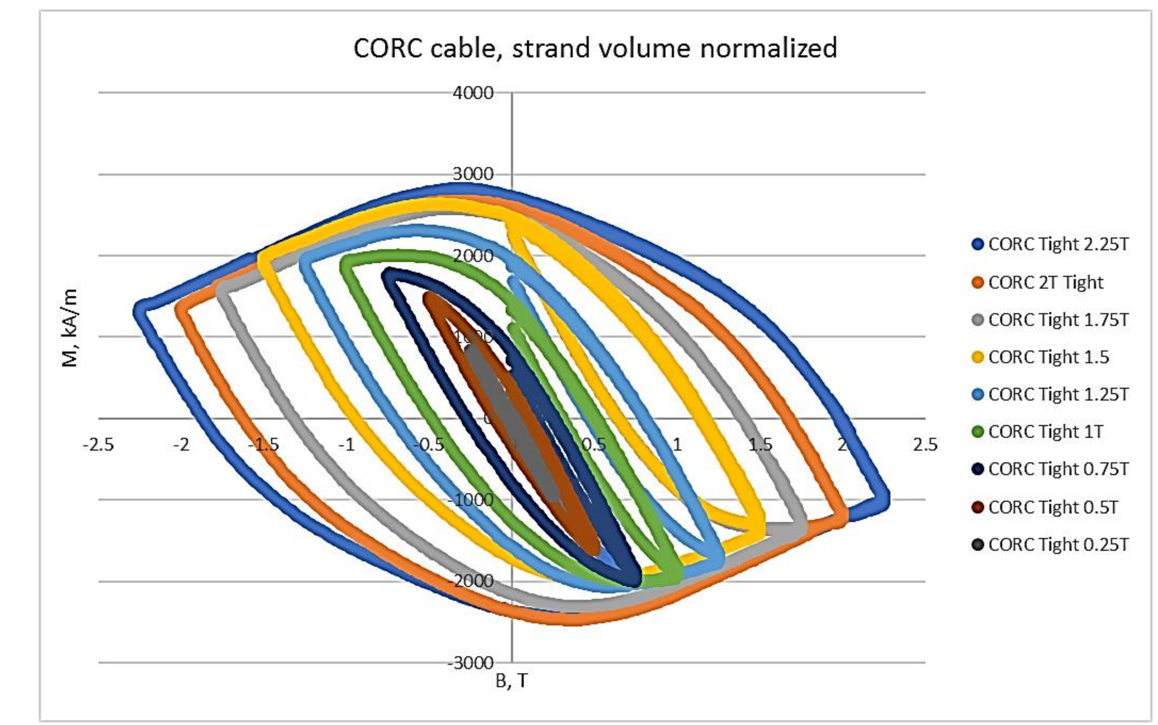
<u>For Tape A:</u> I_c = 262 A per tape (0.04 mm thick, 2 mm wide, gives J_e = 262/.08 mm^2 = 3275 A/mm^2 = 3.27 x 10^9 A/m^2)

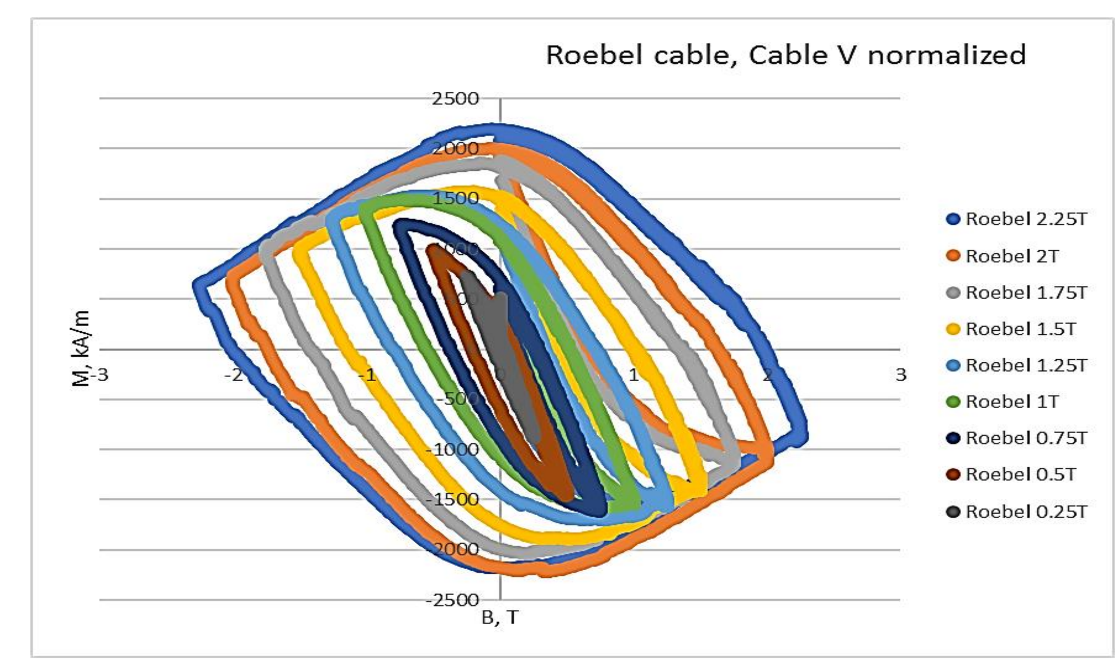
<u>Magnetization Tape A:</u> $M=J_c a/2$=3.27 x 10^9 A/m^2 * 10^{-3} m = 3270 kA/m

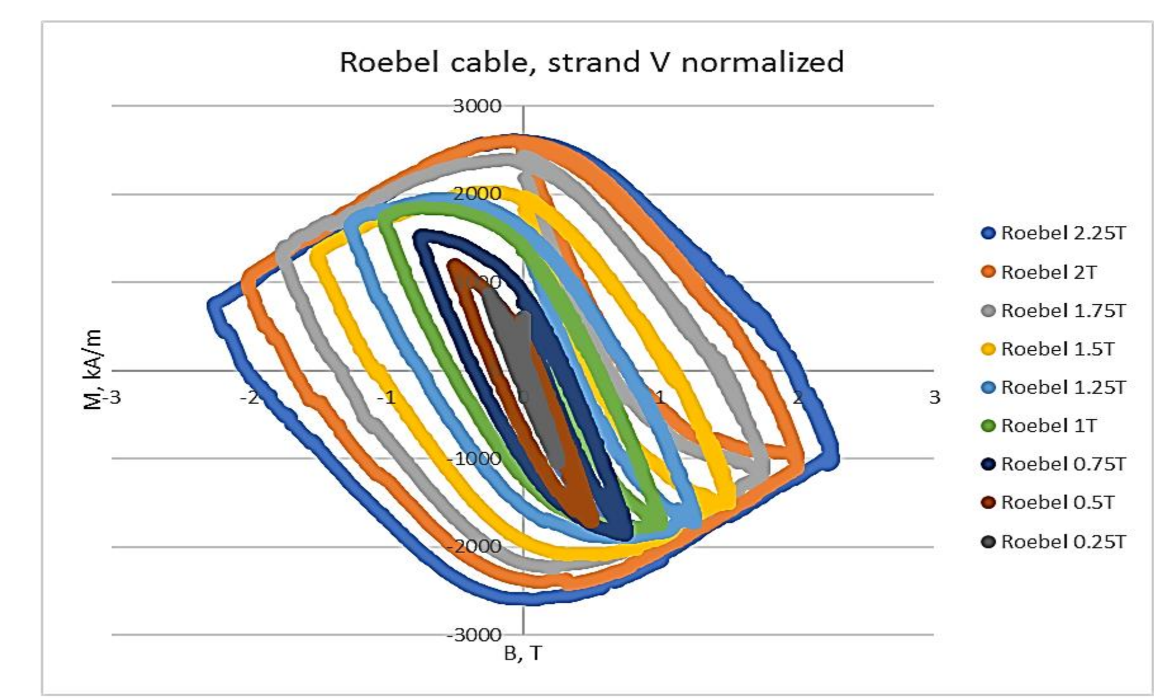
<u>Magnetization CORC A:</u> $M=(2/\pi)M_{tape}$*0.38*0.8= 633 kA/m

<u>Penetration field CORC A:</u> $B_p=\mu_0 J_{c,d} t_{wall}$=*1.25x10^{-6}x3.27x10^9 A/m^{2}x3.79 x 10^{-4}m=1.55 T (about 0.155 T at 77 K)*









Summary/Conclusion

- This CORC sample Magnetization reaches about 900 kA/m (cable volume) and 2200 kA/m (strand volume) near injection
- This Roebel cable reaches about 2000 kA/m (cable volume) and 2400 kA/m (strand volume) near injection
- These values agree well with individual tape values if (i) we normalize to strand volume, Correct CORC for twisting
- These values can be compared to
  - NbTi M_{inj} = 10 kA/m b_3 = 3-6 units
  - Nb_3Sn M_{inj} = 100 kA/m b_3 = 30 units

Here M_{inj} is 100 X higher than NbTi and 10 X higher than NbTi

Not insurmountable, but must be considered when thinking about particle beam steering magnet quality

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